

Realising Africa's hydropower potential

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Recent healthy economic growth across the African continent has exacerbated existing power shortages against a legacy of already low and unreliable access to electricity.

In this difficult environment there is an urgent and unprecedented need for new power generation projects and Africa needs to look at all alternative sources of energy.

Hydropower is one of the oldest and most reliable grid-connected forms of power on the continent and its untapped potential and clean renewable nature mean it should continue to play a large role in the energy mix.

Alex Blomfield, from the London office of **Chadbourne & Parke**, looks at the background of hydropower in Africa, assesses its advantages and disadvantages as an energy source in the African context and discusses some of the risks that need to be dealt with in the financing of these projects.

The article also assesses the potential of funding for hydropower projects in Africa under the Kyoto Protocol's Clean Development Mechanism.

Big dams on the continent

Big dams have long dominated Africa's electricity scene.

For example, Egypt's 2.1GW Aswan Dam on the Nile and Ghana's 768MW Akosombo Dam on the Volta River began producing power in 1967 and 1965 respectively. Mozambique's 2075MW Cahora Bassa on the Zambezi River has supplied a large part of southern Africa's power for almost four decades. These projects and others like them have been a key feature in Africa's development.

Reliable figures are difficult to obtain but estimates for hydropower's share of Africa's power generation generally range between 18 and 32 per cent. However, in many African countries, hydropower's share of total installed electric capacity is much higher, providing over fifty per cent on-grid electricity generation in Cote d'Ivoire, the Democratic Republic of Congo, Ethiopia, Mozambique and Zambia.

In the context of rising fossil fuel prices and increasing concern about climate change, it is worth noting that hydroelectric power is the only significant grid-connected renewable energy source in Africa.

With seven major rivers - Nile, Niger, Congo, Senegal, Orange, Limpopo and Zambezi - Africa is well endowed with hydropower potential. However, exploitation of this potential has historically been hampered by a mismatch in location between demand and supply, which has not been able to be overcome by long-distance transmission line infrastructure.

It is estimated that only seven per cent of Africa's hydropower potential has been harnessed, compared to 33 per cent for Europe and 65 per cent globally. The hydropower potential of the Democratic Republic of Congo alone is reported to be sufficient to provide three times as much power as Africa presently consumes.

Given the very low energy per capita energy consumption in Africa, rising levels of economic growth and recognition that power is a crucial prerequisite to development, the demand for electricity in Africa is set to increase dramatically. As a tried and tested source of power with significant unexploited potential, it makes sense for Africa to look to hydropower to meet a large part of this demand. This is likely to include both new greenfield development and rehabilitation and operational improvement of existing hydro plants to restore and increase capacity.

Many new projects are planned or are under construction. The financial closing in December 2007 of Uganda's 250MW Bujagali project on the Nile near Lake Victoria should inspire confidence in private sector investors, governments and development institutions that a hydropower project in Africa can be financed on a project finance basis.

With construction of Bujagali ahead of schedule, Uganda's attention has now shifted to kick-starting construction of two proposed hydropower dams at Karuma and Isimba.

A large number of other African countries are currently planning or carrying out new hydropower projects in Africa including Angola, Cameroon, Democratic Republic of Congo, Ethiopia, Equatorial Guinea, Ghana, Guinea, Kenya, Liberia, Madagascar, Mozambique, Namibia, Nigeria, Senegal, South Africa, Sudan, Tanzania and Zambia.

Without doubt the most ambitious of these plans is for the Grand Inga Project in the Democratic Republic of Congo, which at 39,500MW could power all of Africa by itself. The World Energy Council convened talks in London earlier this year among potential investors in this mammoth project.

Advantages of hydropower for Africa

As a well-established, proven and simple technology hydropower provides reliable power with low operations and maintenance costs (despite high upfront construction costs).

It also has a number of technical attributes which make it attractive. When stored in large quantities behind a dam, it is immediately available for use when required. This fast response time mean that it is flexible to react immediately to load demand changes and cover valuable peak demand allowing for the best use to be made of base load power from other less flexible electricity sources, notably wind and solar.

Furthermore, hydropower performs well at the so called ancillary services including spinning reserve, operating reserve, regulation and frequency response, voltage support and black start capability, which means it can interface well with transmission grids. This can assist in stabilising transmission grid systems, which may often not be in optimal condition. Notwithstanding its unique ability to provide peak capacity, hydropower is most commonly used to provide baseload power in Africa.

When life-cycle costs are examined, hydropower consistently has the best performance among energy generation sources, with operating costs being low in comparison with the capital investment and average plant life being longer than for fossil fuel and other renewable power sources. With the increasing scarcity and cost of fossil fuel, this advantage can be expected to become even greater.

Hydropower is clean, climate-friendly and renewable power. It is probably not entirely emissions free as studies have shown that the decomposition of plant matter in reservoirs can emit methane which is a greenhouse gas even more harmful than carbon dioxide. However, notwithstanding these emissions, it has significantly less greenhouse gas emissions than fossil fuels, typically one fifth those of a typical coal plant.

These attributes make hydropower an attractive option for Africa in the context of climate change, particularly given its abundance in the continent. Carbon markets provide further incentives to develop such projects, as is set out in greater detail below.

Finally, hydro-projects' advantages are not limited to power generation but can also benefit water supply, irrigation, navigation, fisheries and tourism. This is not the case for any other source of power.

Disadvantages of hydropower for Africa

The high upfront capital costs of hydropower projects are a barrier to their development in Africa, where both government and private finance for large projects is usually scarce.

Moreover, the inadequate local capital markets and the lack of long-term financing in many African countries

make financing hydropower plants difficult and the involvement of international development institutions or foreign government aid a frequent prerequisite.

Hydropower projects also tend to have lengthy lead times for planning, permitting, and construction. These lead times can combine with hydrological, geological, geotechnical and siltation risks to make investment by private investors more risky and difficult than is the case for other power projects.

In addition, social and environmental issues are often sensitive and can lead to strong opposition by some non-government organizations and local communities to the approval of some projects.

Hydropower depends entirely on precipitation. Therefore, low rainfall and drought - both seasonal and longer-term cyclical in nature - can affect its reliability. Indeed, many of Africa's dams operate at below capacity due to variable rainfall, siltation or poorly maintained infrastructure, including turbines and other equipment and transmission and distribution lines and facilities.

The exploitation of hydropower's potential in Africa also faces the same difficulties that other projects in developing economies face including an uncertain regulatory environment, poor governance, a sub-optimal general investment climate and local conflicts and political instability.

Financing hydropower in Africa

Hydropower projects require long construction periods and high capital costs. As a consequence, the viability of these projects relies critically on long debt tenors and a financing structure which is often not available from private lenders alone.

The financing structure will have a critical impact on the tariff which needs to balance return on investment against the offtaker's ability to pay and recover this cost from consumers.

These characteristics, combined with the old fashioned view of power as a public good, has meant that hydropower in Africa has traditionally been financed by public money. Such money has often supplemented by development assistance or concessional loans from development finance institutions.

However, as evidenced by the successful closing of the Bujagali project in Uganda, there is a definite trend towards more private funding of huge dams as public finances are not up to the task of funding enough power generation to keep up with demand and future growth projections.

The financing of private power projects is generally through sponsor's equity and debt raised on a non- or limited recourse basis on the strength of the project's revenue stream and securities provided by the project itself. If things go wrong, lenders have little or no recourse to the project sponsors' underlying balance sheet.

Under such arrangements lenders naturally take a close interest in the viability of the project, particularly when (like hydro) it involves uncertain output and high construction risks. Lenders in Africa will look at risks typical of independent power projects in any emerging market including a project's economics, potential to export power, demand growth for power, regulatory and political risk, payment risk based on the creditworthiness of the offtaker, currency risk and the availability of mitigants such as insurance to lessen their risk profile. Typical debt:equity ratios for hydro projects are in the region of 70:30.

In addition to the familiar emerging markets risks, hydropower presents unique risks that need to be mitigated including negative public perception, project delay and cancellation arising out of social and environmental issues, hydrological uncertainties, geological and geotechnical risk, high upfront capital investments and the potential of water use conflicts within communities and with other countries.

Social & environmental issues

It is difficult to overstate the importance of properly dealing with the social and environmental issues that hydropower projects can present. These issues are often controversial and intensely political. They have the

potential to delay progress on projects or even lead to their demise.

Although, with the exception of emissions from reservoirs, hydropower projects do not emit significant airborne pollutants or gases that cause global warming, changes in the use of water resources can have negative implications on people, animals, plants and entire river ecosystems. Accordingly "environmental assessment," when applied to hydropower projects, must include broader concern about environmental impacts and social impacts on people that may be displaced or whose water source and ecosystem may be changed by hydropower projects.

A failure to properly design or plan projects with such impacts in mind can mean the cancellation of projects. For example, a plan to build a large hydro power scheme east of Namibia's Epupa Falls was finally abandoned this year largely due to its expected impact on the nomadic Ovahimba community, who live on both sides of the Kunene River, which was to have been dammed by the project.

Large hydropower projects in Africa often have a legacy of needing to resettle sizable numbers of people. Bodies such as the World Bank have now set standards for resettlement to mitigate some of the issues that such actions can pose. An important principle in those standards is that of compensation for those who need to resettle. There may also be relevant local law in respect of expropriation and compulsory acquisition of property.

The World Commission on Dams was established in 1998 as an independent, international, multi-stakeholder process to address the controversial issues associated with large dams.

In its November 2000 report entitled "Dams and Development - A New Framework for Decision-Making", the WCD made certain recommendations to ensure that the social and environmental aspects of large dams are addressed adequately in the planning, construction and operation of hydropower projects.

To follow WCD recommendations, a project must start with a needs assessment rather than starting with a proposed solution to an undefined problem. A needs assessment is followed by an options assessment that engages all stakeholders and utilises a transparent decision-making process. Decisions should value ecosystem, social and health issues as an integral part of project and river basin development, and the avoidance of impacts is given priority, in accordance with a precautionary approach.

Some countries, including South Africa and Uganda, are working to incorporate the WCD's recommendations into their national policies and laws.

Another way of mitigating environmental and social risk is by involving multilateral and bilateral development institutions in the financing. For example, the World Bank has adopted strict environmental standards that must be met by any project financed by the World Bank Group, including the International Finance Corporation, International Development Association and Multilateral Investment Guarantee Association.

World Bank or development institution involvement can ensure compliance with international best practice, which may not be obtained without the application of the such standards. These are generally much more detailed and prescriptive than the Equator Principles to which a number of commercial banks profess to adhere.

As a general matter, it is prudent to rigorously research and plan in respect of social and environmental issues. Studies should identify risks early so that they can be mitigated and a project's design amended as required. Once identified, these issues should be continuously assessed, including monitoring once the project is in operation.

A number of non-government organisations actively monitor plans to develop large dams in Africa and can be relied upon to expose issues. Governments and developers who do their homework will be better placed to avoid issues in the first place and navigate any controversies that may arise.

Lessons from past mistakes need to be learnt so that projects can be better in the future. Project developers may find that host governments are best placed to mitigate environmental and social risks and would be well advised to involve host governments in these issues as early as possible.

Hydrological risk

Hydrological risk is the risk that a lack of rainfall or water conditions otherwise will not be sufficient to produce power at the designed capacity of a hydropower plant.

The unpredictable nature of Africa's weather means that this is a key concern for hydropower plants in the continent. For example, the output of hydroelectric facilities in East Africa was badly affected by droughts in 1999-2000, with Kenya in particular suffering from power shortages. Ghana's hydroelectric facilities were also adversely affected by droughts during the late 1990's, and Cameroon uses thirty diesel stations as back-up power during extended droughts.

These unpredictable conditions have meant that a number of African governments are changing their available mix of generation sources to be less dependent on hydroelectric power. Other countries are reviewing hydroelectric facilities, increasing dam storage capacities to allow for fluctuations in water supply.

Furthermore, the increasing prominence of the climate change issue and the likelihood that global warming will lead to increased prevalence of droughts has brought the issue of hydrological risk into sharper focus.

Siting and design of a hydropower project should be based on the best available reliable historical rainfall data. However, even the best planning and design can not produce rainfall. Generators should take care to ensure that low water conditions arising out of prolonged drought afford them force majeure relief in their power purchase agreements. Offtakers could attempt to negotiate a termination right for prolonged low water conditions.

On a more macro level, since rainfall across the continent is not uniform and droughts rarely affect all countries simultaneously, perhaps the best mitigation of hydrological risk is better investment in regional transmission infrastructure. This would allow hydroelectric facilities in non-drought affected countries to make up any shortfalls in generation during times of drought in another country.

Geological and Geotechnical risk

The engineering properties of soil and rock often exhibit significant variability from one location to another. It is important to conduct a comprehensive site investigation including adequate drilling and testing of these properties before project sponsors commit to a project. Geological and geotechnical expertise should also be available throughout the construction process.

Water use obligations

In addition to the impact of drought, allocation and use of water resources for hydropower can be affected by domestic water law. This may give rights for irrigation and fisheries and riparian states' obligations under international water law, including the 1966 Helsinki Rules on the Uses of the Waters of International Rivers, the 1997 United Nations Convention on Non-Navigational Uses of International Watercourses and various regional treaties, which oblige certain African countries to share their water resources in an equitable manner. Due diligence on the applicability and effect of these water law obligations needs to be completed at an early stage of a project's planning.

Carbon funding

Carbon credits under the Kyoto Protocol's Clean Development Mechanism have been obtained by a large number of hydropower projects worldwide. There are over 1,000 hydropower projects in the CDM pipeline. Only a small number of these, such as the 3.5MW West Nile Electrification Project in Uganda, are in Africa and these often enjoy World Bank backing.

Indeed, it has been World Bank policy since 2003 to seek CDM funding for the hydropower projects it funds. This policy has not been without controversy for two main reasons. Firstly, critics contend that many hydropower projects would occur without CDM funding thus not meeting the "additionality" requirement of Kyoto. Secondly, some have argued that many World Bank hydropower projects do not follow the World Commission on Dams

recommendations. This view has found favour with buyers of carbon credits and the so-called Linking Directive of the European Union on greenhouse gas emission trading (2004/101/EC) now mandates that hydro projects above 20MW must "respect" the WCD to be eligible for credits under the European Emissions Trading Scheme.

There are signs that scrutiny of hydropower projects claiming CDM credits is set to increase even further. The executive board of the CDM recently noted that an auditor of a hydro project in China had refused to recommend the project for registration, raising questions about whether similar projects will fail to get international carbon credits used by companies and governments to meet binding emissions targets.

There are also reports that developers of large hydropower projects seeking to gain CDM credits for cutting emissions may soon have to gain independent verification from a third party that the projects comply with an European Union backed checklist on sustainability under new guidelines being drawn up by member states.

A challenging but important part of the energy mix

In many respects the difficulties and challenges of financing and implementing a successful hydropower project in Africa are not dissimilar to those faced by other power projects.

However, in addition to those risks, hydropower presents unique risks arising out of social and environmental issues, hydrological uncertainties, high upfront capital investments and the potential of water use conflicts within communities and with other countries. If those risks can be overcome, hydropower is a clean and renewable source of power which is useful to have in the generation mix when it is working.

When it is not available due to drought or otherwise, emergency power from diesel or other fuel oil can be expensive. For that reason, African countries should diversify their generation mix so that it is not overly dependent on hydropower. Africa should also invest more heavily in its transmission infrastructure and the development of regional power markets so that a shortfall in hydropower generation in one country can be met by supply from another where drought is not prevailing.